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REVIEW ARTICLE

Biology and fishery of Acoupa Weakfish *Cynoscion acoupa* (Lacepède, 1801): a review

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Abstract

The present study describes the fishery and biology of Acoupa Weakfish *Cynoscion acoupa*, an important fishery resource in South America. We found and analyzed 31 articles and 10 publications about the species. *Cynoscion acoupa* is an estuarine marine species, which has a feeding habit with preference for fish and crustaceans. Its spawning occurs during two periods of the year and the size at maturity of females is 40 to 50 cm, while males mature earlier, with 38–40 cm. Their growth is considered slow to moderate, with growth coefficient *k* ranging from 0.13 to 0.28, and the species can reach up to 15 years of age. *C. acoupa* is target of commercial and recreational fisheries in estuarine and marine coastal environments, mainly in the northern region of South America. The fisheries occur throughout the year, with different fishing gear, being more frequent with gillnets. In addition, fishing is more frequent on juveniles, which may compromise the stock. This species is categorized as of Least Concern by the International Union for Conservation of Nature, although it has a high degree of vulnerability to fishing, which, combined with overexploitation, shows that *C. acoupa* should be listed as under threat of extinction to some degree. The lack of studies on the species makes it difficult to establish management measures. Therefore, further studies should be prioritized, especially on reproductive biology, growth and fishing exploitation.

Keywords

age and growth, artisanal fisheries, conservation, reproductive biology, Sciaenidae, South America

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Introduction

Cynoscion acoupa (Lacepède, 1801) is a species from the Sciaenidae family with high commercial value in fisheries, especially in the northern region of South America (Morales and Montaño 2011; Levrel 2012; Chao et al. 2015). This species is widely distributed in the western Atlantic Ocean, in demersal waters, and inhabits estuarine and marine environments (Matos and Lucena 2006), and the diet of *C. acoupa* is mainly composed of fish and crustaceans (Ferreira et al. 2016).

According to Chao et al. (2010), *C. acoupa* has a number of synonyms: *Cestrus acoupa* (Lacepède, 1801), *Cheilodipterus acoupa* (Lacepède, 1801), *Cynoscion maracaiboensis* (Schultz, 1949), *Otolithus rhomboidalis* (Cuvier, 1829) and *Otolithus toeroe* (Cuvier, 1830). Its common name varies according to the countries of occurrence (e.g., in Brazil it is popularly known as "pescada amarela", in Venezuela as "curvina" and in French Guiana it is "acoupa rouge"), but globally this species is known as acoupa weakfish (FishBase 1999; FAO 2019).

This species can reach more than 100 cm in total length. Its features are elongated body; moderate head; slanted mouth with lower jaw protruding slightly in front of the upper (1); Canine teeth with an anterior pair in the upper jaw larger than the others; rhomboidal flow (2); silver-gray color with darker back (3); lighter belly, with large yellow areas including the flank and lower fins (4); anterior dorsal fin with 10 spines, posterior with 1 spine and 17 to 22 rays; anal with 2 thorns and 7 to 8 rays; with 19 to 19 rays (Fig. 1) (Menezes and Figueiredo 1980; Cervigón et al. 1992; Brasil 2016).

Cynoscion acoupa has high commercial value and therefore populations of this species have been highly exploited and productions declining (Matos and Lucena 2006; Almeida and Nahum 2015; Neto and Dias 2015; Martins et al. 2019). Nevertheless, this species is categorized as of Least Concern (LC) in the Red List of Inter-

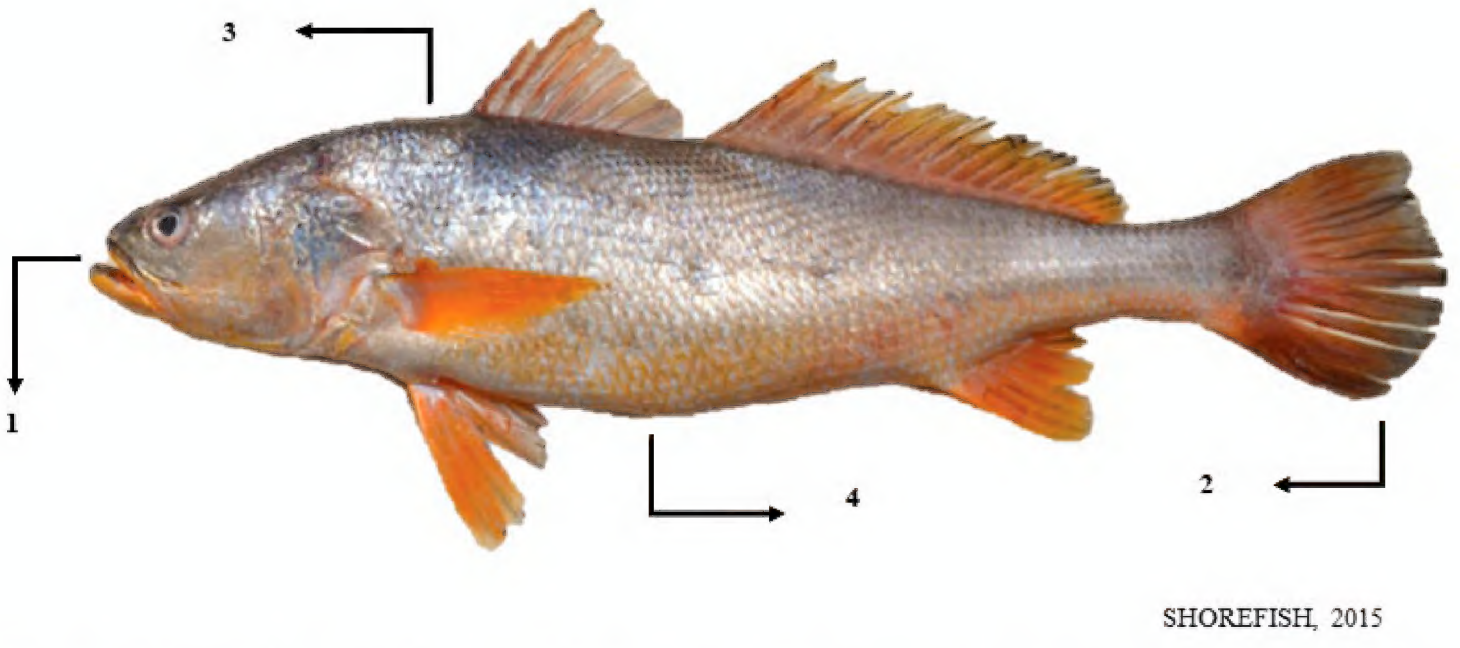

Figure 1. Exemplary of *Cynoscion acoupa* indicating the main characteristics cited in the text. **1** – mouth with lower jaw protruding; **2** – rhomboidal flow; **3** – silver-gray color with darker back; and **4** – flank and belly coloring.

national Union for Conservation of Nature – IUCN (Chao et al. 2010), mainly due to the lack of data on biology, ecology and fishery.

Although *C. acoupa* has a high economic value, data on biology and fisheries are scattered and limited in many knowledge fields, making its management and conservation strategy difficult. For these reasons, the present study aimed to compile and analyze available information from the literature on the biology and fishing of *C. acoupa*, as well as identifying gaps in knowledge about this species.

Scientific production

For the review, articles on *Cynoscion acoupa* were searched in research bases: Web of Science and Google Academic using the keywords: "Cynoscion acoupa" OR "acoupa weakfish" OR "pescada amarela" OR "acoupa rouge". Only the scientific articles found in the search were selected. From these articles, the title, year of publication, country of study and authorship were extracted. Moreover, each article was classified according to its broad theme, and could sometimes be classified into more than one theme.

Only 31 articles were found (Suppl. material 1: Table S1); of this total 3.2% were in French Guiana, 9.7% in Venezuela and 87.1% in Brazil. The first article published about *C. acoupa* occurred in 1973 in Brazil. The years with the highest number of publications about the species were 2016 and 2018 (Fig. 2A). Regarding the themes, there are more publications about fishing, and relatively little on the biology and ecology of the species (Fig. 2B).

Fishery data are critical for assessing fish production as well as understanding fishing dynamics and effort. Nonetheless, the lack of data on the biology of this species, especially regarding reproduction (e.g., spawning period and maturity size) and growth (e.g., growth rate and longevity), makes it difficult to evaluate fish stocks, causing errors and compromising the fishing resource. Therefore, research on reproduction, growth, habitat use, feed and fishing should be encouraged so that there is more current and more reliable decision-making data on *C. acoupa* management.

Biology

Distribution and habitat use

Cynoscion acoupa occurs in the western Atlantic Ocean in tropical and subtropical waters, from Panama to Argentina in both marine and estuarine environments (Matos and Lucena 2006; Almeida et al. 2009; Chao et al. 2015). However, when using data available from the Global Biodiversity Information Facility **GBIF** (https://www.gbif.org/), it is noted that the occurrences recorded were from Panama to Southeastern Brazil (Fig. 3).

Cynoscion acoupa is a species estuary dependent, generally reported for Sciaenidae species, and in addition, this species is typically observed on soft bottom or sandy substrates (Cervigón et al. 1992). The connectivity between the estuary and marine coastal zone provides unique attributes of habitat and important features

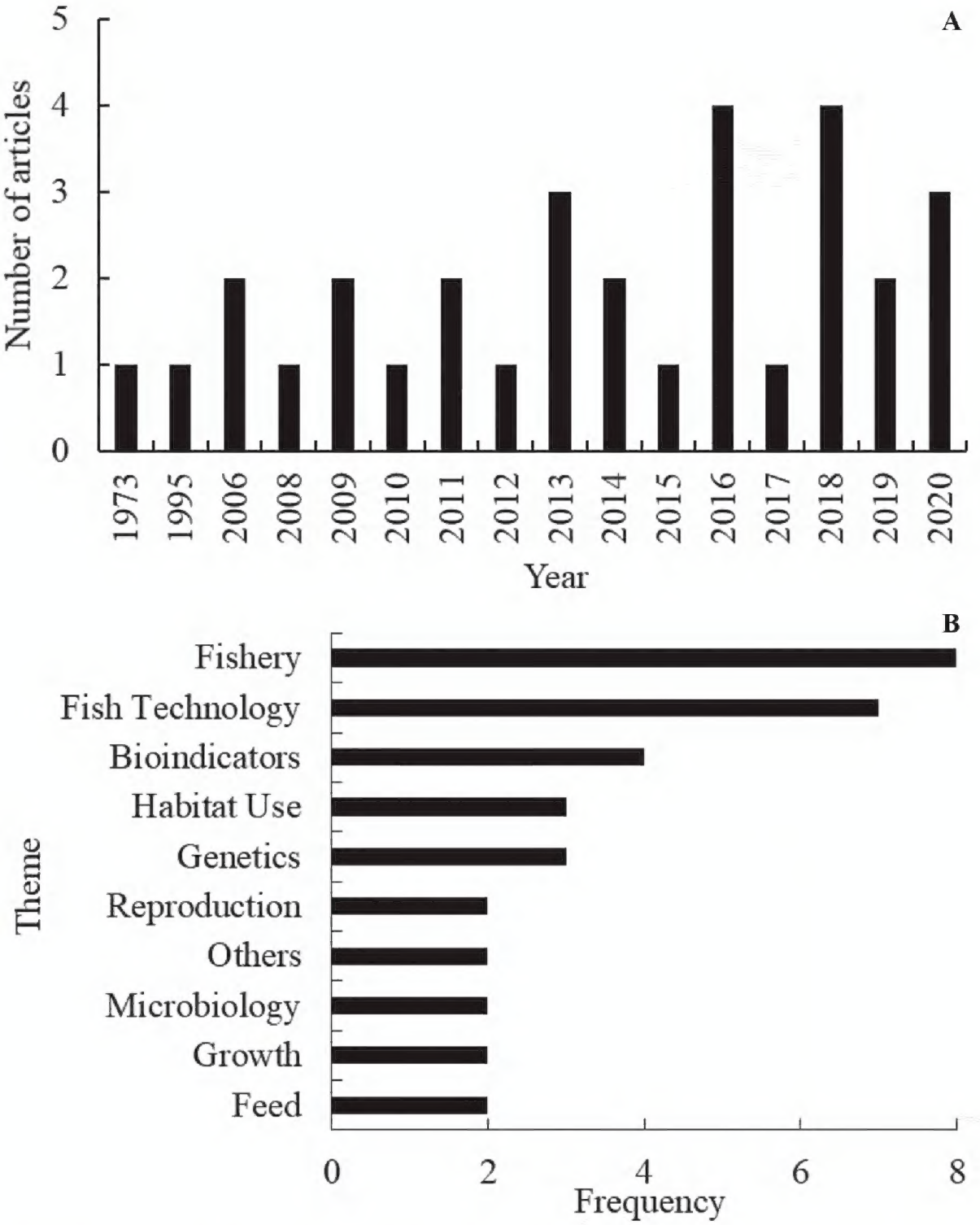

Figure 2. Scientific production about *Cynoscion acoupa* by year (**A**) and by theme (**B**).

for this species, serving as a nursery and growth area (Barletta-Bergan et al. 2002; Barletta and Saint-Paul 2010), explaining its most common occurrence in estuaries or coastal environments with strong river influences.

Vane et al. (2018) suggest, from otoliths isotopic analysis studies, the existence of ontogenetic migration between the estuary and the coastal environment besides changes in resource utilization for *C. acoupa*. Therefore, these authors observed that juveniles and adults gradually use distinct environments (juveniles use estuarine while adults uses the marine coast) and overlap in intermediate stages of life, which may indicate that there is a regular movement between estuarine and coastal environments by *C. acoupa* juveniles. Finally, freshwater and marine phytoplankton are more used as a feed by *C. acoupa* juveniles.

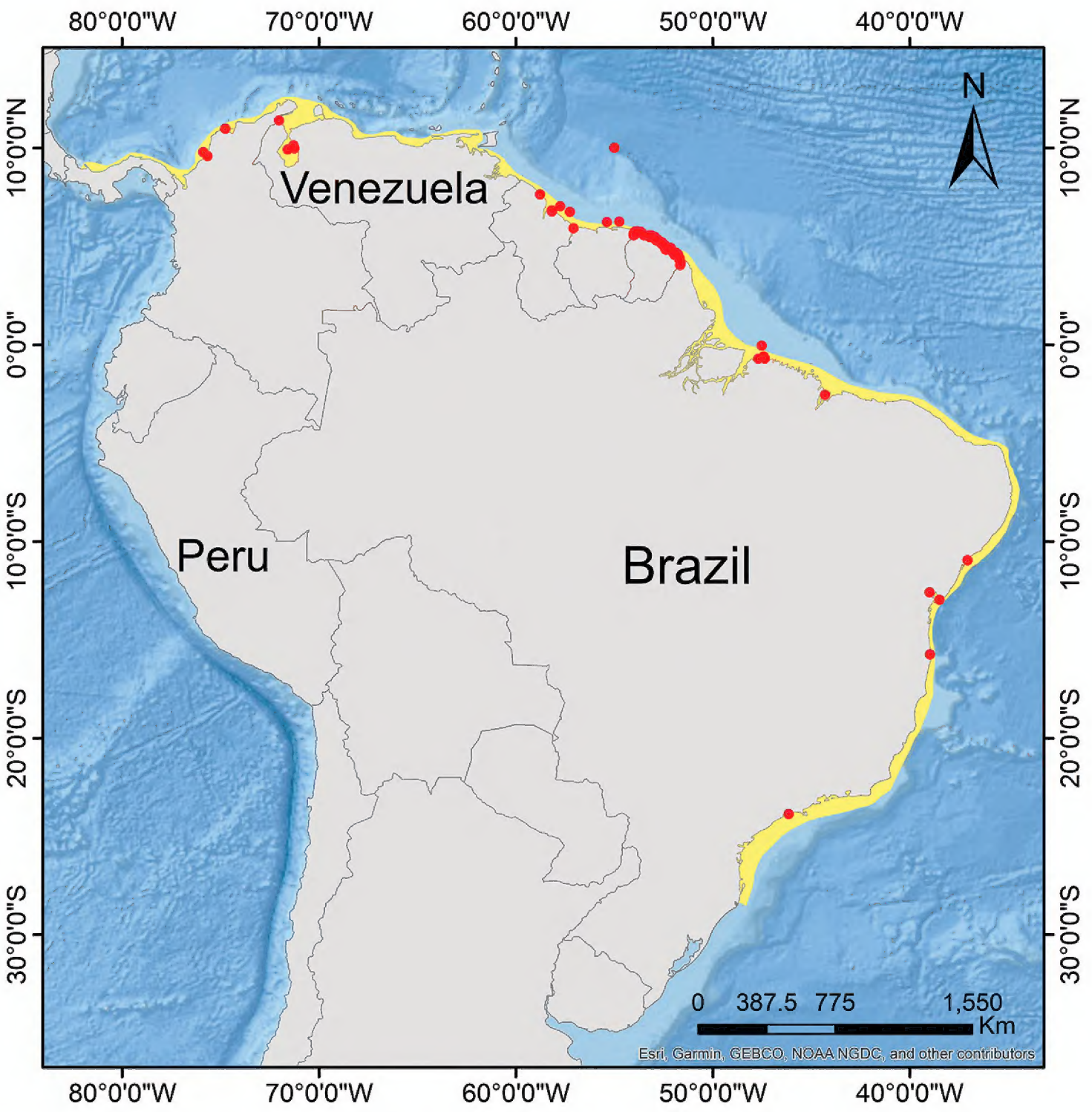

Figure 3. Area of occurrence (yellow – IUCN) and registration points (red circle) of *Cynoscion acoupa* according to data from Global Biodiversity Information Facility 2019.

In relation to feeding habits, Ferreira et al. (2016) also concluded that there was a difference in the feeding of *C. acoupa*. In their work, the stomach contents of 530 specimens were analyzed (469 juveniles, 25 sub-adult and 33 adults). In general, *C. acoupa* diet consisted of crustaceans (57.3%), fish (31.2%), Polychaeta (16.5%), bivalve molluscs (0.2%), algae (0.2%) and plants fragments (2.9%). For the juveniles, crustaceans (34.3%) and bivalve molluscs (17.2%) stood out, while for the sub-adults and adults others fish (40% and 48.3%, respectively) stood out.

Differences in habitat use among the life stages of *C. acoupa* can be observed, occasioned by the environment type and the organism's diversity, especially those that are part of the diet of *C. acoupa*. The estuarine environment is important for the species' life cycle, due to the high diversity of food for *C. acoupa*.

Population genetics

Genetics studies of *C. acoupa* were developed, mainly in Brazil, with a focus on identifying the genetic variability of the species and identifying possible populations of *C. acoupa* in the north region of the country. These studies detected a low genetic diversity for this species and, possibly, there is only a single population in northern Brazil (Farias et al. 2006; Rodrigues et al. 2008).

Rodrigues et al. (2008) when analyzing this genetic variability, used a sample of 297 adult specimens of *C. acoupa*, in which the total DNA was isolated from muscle tissue using the conventional phenol-chloroform protocol according to Sambrook et al. (1989). The authors observed moderate diversity of haplotypes and very low nucleotide diversity. In summary, these authors identified 83 different haplotypes; 51 (66.26%) of these occurred only once, 11 were found in two specimens, while the remaining haplotypes were found in three or more specimens. This finding may conclude that there is only a single population of *C. acoupa* on the northern coast of Brazil. Similar results were reported by Farias et al. (2006), who pointed out that the population of the state of Amapá (Brazil) is the same as that of the state of Pará (Brazil), thus implying that the Amazon plume is not blocking the gene flow between subpopulations of *C. acoupa*.

Furthermore, this low genetic variability may be the result of overexploitation of this species. According to Dulvy et al. (2003), overexploitation can be identified as one of the two main causes of marine species extinction, together with environmental degradation, reducing the breeding stock and consequently decreasing the genetic diversity of the populations (Rodrigues et al. 2008).The low levels of genetic variability, observed in these studies, can compromise the evolutionary plasticity of *C. acoupa* population, further indicating the urgent need for monitoring and management of *C. acoupa* fishing in northern Brazil.

Reproductive biology

Reproductive biology studies are a fundamental step towards understanding and decision-making for fish conservation. These studies indicates the ability of the species to reproduce, as well as indicate spawning periods and assist in a minimum catch size model (King 1997; Cavalcante et al. 2012). Nonetheless, few studies on the reproductive biology of *C. acoupa* have been carried out. So far only three studies have been reported: (i) Espinosa (1972) and (ii) Montaño (1995), both in Venezuela, and (iii) Almeida et al. (2016) in Brazil.

The length of maturity was estimated by Espinosa (1972) to *C. acoupa* close to 50 cm of total length (**TL**); however, Montano (1995) reported that the L_{50} for males and females was 38.1 and 40.0 cm TL, respectively, in Venezuela. This difference may be an indication that individuals began to mature earlier in an attempt to recover inventory, as has been observed for rocket hake (*Macrodon ancylodon*) in southern Brazil (Carneiro and Castro 2005). Corroborating these values, Almeida et al. (2016) also found similar values, 39.9 and 42.1 cm of TL for males and females,

respectively. Therefore, the maturation length of *C. acoupa* occurs practically when the species reaches 1/3 of its maximum length.

The data of fecundity and spawning of *C. acoupa* are restricted in only one study carried out in Brazil. The number of oocytes found by Almeida et al. (2016) varied between 5819020 and 14340373, for specimens with TL and weights of the gonads varying between 85 from 93.5 cm of TL; and 142.35 and 437.22 g, respectively, with a mean absolute fecundity of 10171348 oocytes (standard deviation = 3393719 oocytes). Mean relative fecundity was estimated in 1.314 oocytes/g of total weight of females. The gonadosomatic index (GSI) indicated two spawning periods for females, one between March and April, and another between November and December. Thus, *C. acoupa* can be considered a species with high fecundity and it is a common characteristic of fish that have free eggs and with total spawning (Araújo 2009).

In addition, male and female ratio data is also a good index for reproduction information. According to Jorgensen et al. (2006), the proximity of male to female ratios may be a mechanism to improve fertilization, since male and female aggregation increases reproductive probabilities. Almeida et al. (2016), described a slight predominance of males (1.35 for each female) of *C. acoupa* in the state of Maranhão (Brazil), which should be related to the greater size of males in relation to females, which makes them more vulnerable to fishery. In French Guiana, the proportion found by Levrel (2012) was 1.16 females for each male, not significant to a 1:1 ratio.

Therefore, *C. acoupa* presents late maturation; however, it reproduces throughout the year, with two peaks, which are related to the rainy season (Almeida et al. 2016). This species also presents high fecundity, following the expected for fish that have free eggs and no parental care (Araujo 2009). Nonetheless, more studies on the reproductive biology of the species should be performed, because data on this subject are still lacking.

Age and growth

The length-weight relationship estimated by several studies reveal similar coefficients in different areas to *C. acoupa* (Table 1). The relative growth between weight and length for this species in Brazil presented a positive allometry ($b > 3$), showing that the population has a greater weight in relation to length, the opposite of what was found in French Guiana, where a negative allometry ($b < 3$) was observed. This relative growth may be related to the kind of environment that the species inhabits and the availability of feed in this location. In Brazil, the study areas related to this species' occurrence are present in estuaries and nearby rivers. Consequently, there is a greater availability of feed, thus making the species feed more and have greater weight gain than in French Guiana.

Few studies on age and growth with majority were conducted based on length frequency distributions (modal progression analysis), which revealed that the species has relatively fast growth, according to the growth coefficients (k), which resulted in values between 0.22 and 0.28 (Table 2). In the only study carried out with the observation on the otolith growth rings (Oliveira 2018), a slower growth of *C. acoupa* was estimated in the state of Maranhão (Brazil), half of which was described by other

Table 1. Length-weight relationships of *Cynoscion acoupa* from studies carried out in South America (n = number of samples in the study, a = coefficient of proportionality, b = allometric coefficient, r^2 = coefficient of determination).

Author	*n*	*a*	*b*	r^2	Country
Joyeux et al. 2008	77	0.004	3.200	0.995	Brazil
Levrel 2012	–	0.012	2.914	0.961	French Guiana
Silva Júnior et al. 2017	294	0.017	3.030	0.960	Brazil
Oliveira 2018	255	0.007	3.028	0.995	Brazil

studies (Table 2). These divergences can be related to the different methodologies used by the authors. The length frequency distribution method presents several limitations related to the selectivity of the fishery gear used to capture individuals, which will have caused bias in the number of specimens by age analyzed and, in the presence or in the absence of individuals in all classes of lengths present in the life cycle.

Growth curves according to the von Bertalanffy growth model by author (Fig. 4) were similar, except that proposed by Souza et al. (2003), probably due to the maximum length found by the authors (165.3 cm). The growth curve proposed by Oliveira (2018), using the annual rings in otoliths, also presented different growth from the other. A slower growth was observed in the initial ages, when compared to the others curves, faster and without stabilizing in the final ages.

The estimated maximum age for the species was 15 years-old in French Guiana, according to Levrel (2012). In Brazil, Neto and Dias (2015) suggest that *C. acoupa* can reach up to 12 years-old with a length of 180 cm TL. Oliveira (2018) observed that the oldest individual collected in Brazil, presents 10 years of age, showing a slow growth and a high longevity among the teleost.

Therefore, it is possible to verify that this species possibly presents a slow or moderate growth (Froese et al. 2000); however, the low number of studies precludes a deeper conclusion, mainly due to the lack of studies using the rigid structure methods. In addition to slow/moderate growth, *C. acoupa* has a high longevity when compared to other species such as *Cynoscion jamaicensis* and *Macrodon atricauda* both with 8-year-old longevity (Castro et al. 2002; Cardoso and Haimovici 2011). *Cynoscion acoupa* has r-strategist characteristics such as high fecundity, but also has more k-strategist characteristics (e.g. high longevity and slow to moderate growth), showing the importance of further studies on its biology to better understand its biological evolution.

Fisheries and fish technology

Fisheries

The species *Cynoscion acoupa* is an important fishery resource in South America, mainly in the northern part of this region and the annual average catch (2002–2018) was 32,653.71 tons. Among the countries of South America that fish this species, Brazil was the main producer, accounting for 57.8% of the total catch in 2011, fol-

Table 2. Age and growth parameters (according von Bertalanffy growth model) of *Cynoscion acoupa* from studies carried out in the South America and obtained through of frequency distribution of length method (except for Oliveira (2018)*, which was performed by counting annual age rings in otoliths). L_{∞} = Asymptotic length in cm, L_{max} = Maximum length in cm, k = Growth coefficient, Φ = Growth performance index, t_{max} = Maximum observed age in year

Author	Country	L_{∞}	L_{max}	k	Φ	t_{max}
Levrel 2012	French Guiana	116.0	110.2	0.27	3.56	15
Montaño and Morales 2013	Venezuela	98.1	–	0.26	3.39	–
Souza et al. 2003	Brazil	174.0	165.3	0.22	3.82	–
Oliveira 2018	Brazil	112.6	107.0	0.28	3.51	10
Oliveira 2018*	Brazil	142.9	107.0	0.13	3.44	10

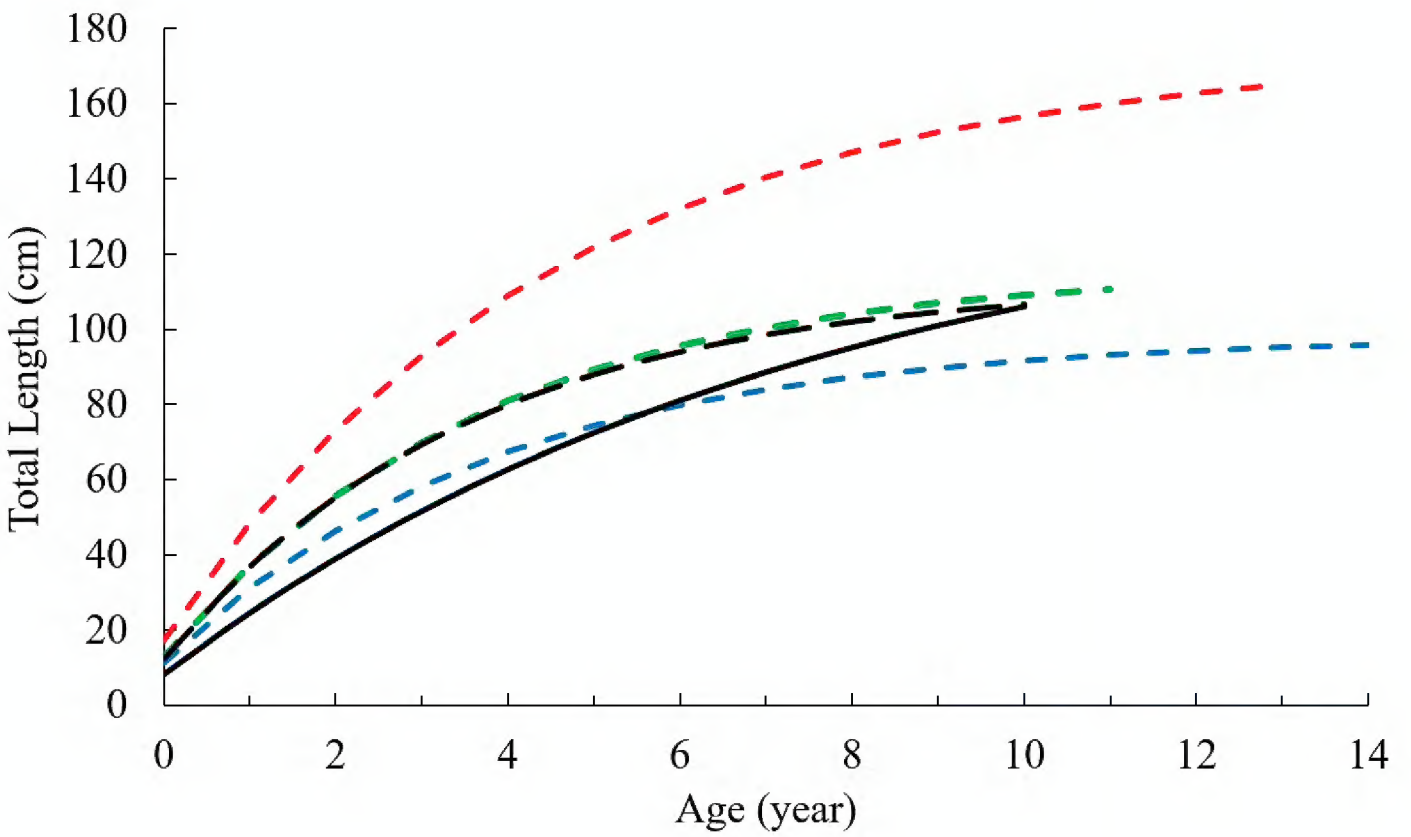

Figure 4. Growth curves of *Cynoscion acoupa* by author. Frequency distribution (dashed line): Souza et al. 2006 (red); Levrel 2012 (green); Oliveira 2018 (black); and Montaño and Morales 2013 (blue) and otolith analysis method (solid line) presented by Oliveira 2018.

lowed by French Guiana (30.0%) and Venezuela (12.1%) (Levrel 2012; FAO 2019). In all of these countries, a decrease in production was evidenced between 2009 and 2011, mainly in French Guiana and in Venezuela – where it was most evident (Fig. 5).

According to Food and Agriculture Organization of the United Nations – FAO (2019) the production of *C. acoupa* in Brazil ranged from 27,559 tons in 2001 to 20,050 tons in 2011, with significant declines in production between 2002 and 2004. After that period the catch remained almost constant, with small variations around 2,000 tons. In French Guiana, there was a decrease in production of approximately 37% between 2009 and 2011 (Levrel 2012). These declines were probably related to

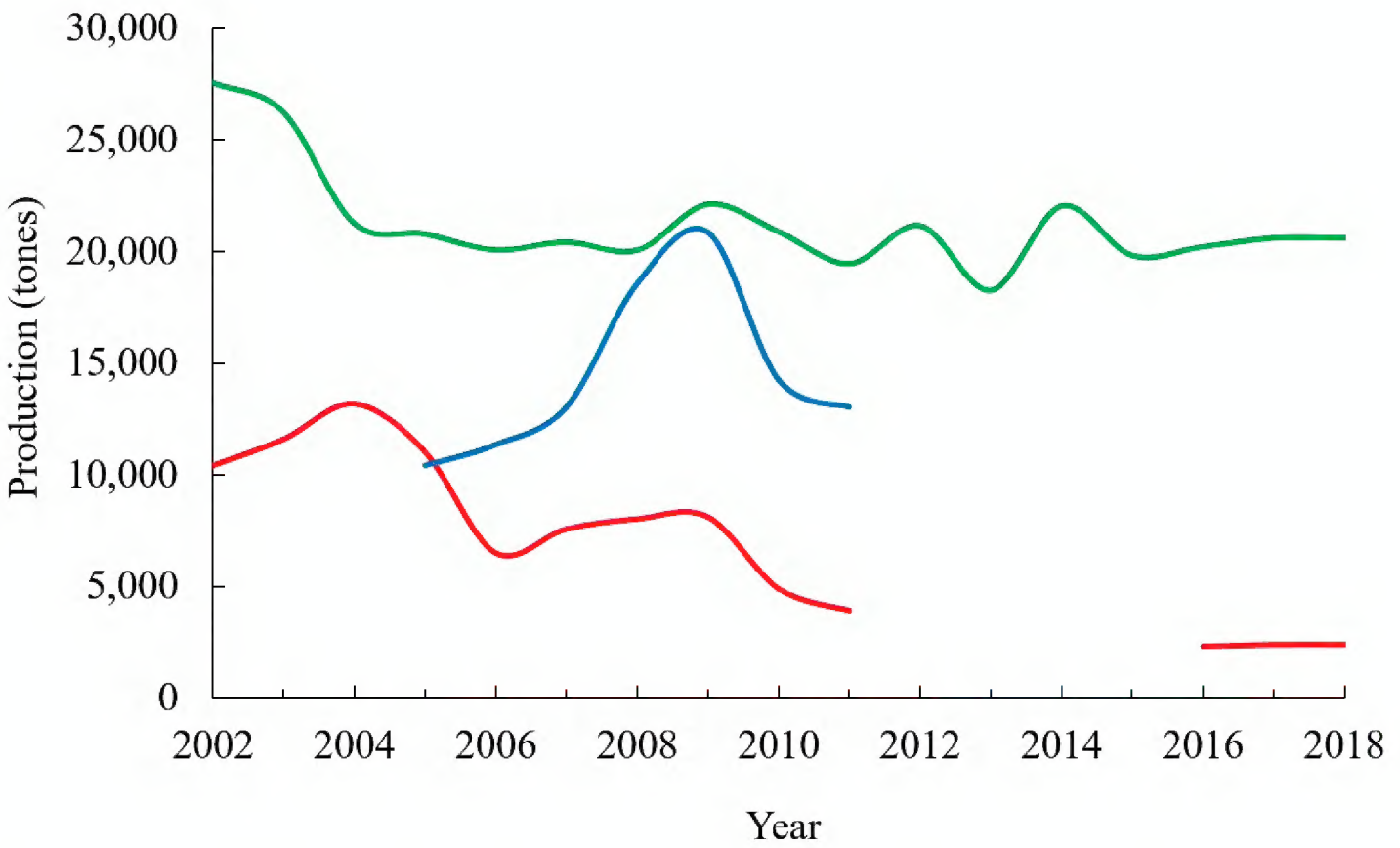

Figure 5. Annual fishery production of *Cynoscion acoupa* in Brazil (green) and Venezuela (red), according to statistics of FAO (2019), and French Guiana (blue) according to Levrel (2012).

the high capture of young individuals. Without this individual's group, the population structure is at risk as there will be no increase in the adult group. An example is Venezuela, with a 62% decline in *C. acoupa* production in the country when compared with data from 2002 to 2011. This decline seems to be linked to a high catch of young *C. acoupa* individuals, which accounts for approximately 90% of the total catch of this species in the country (Montaño and Morales 2013). In addition, another factor supporting this species decline in the countries is the lack of a species-oriented fishing policy, which so far has no restrictions on their capture.

In Brazil, *C. acoupa* is the third most caught fish, mainly in the states of Pará and Maranhão, accounting for 90% of total production of species in the country. The highest fisheries intensity was observed between May and August in Pará, and between December and March in Maranhão (Frédou and Asano Filho 2006; Matos and Lucena 2006; Almeida et al. 2009). In addition to the high catch in the northern portion of this country, the southeastern area, specifically the state of São Paulo, caught 224 tons in 2005, and after 2015, this production decreased to less than 50 tons (Martins et al. 2019).

Cynoscion acoupa, fishing in Brazil by industrial and artisanal fisheries, employs various types of fishing gear (Martins et al. 2019). Nonetheless, in the northern portion there are three fishing gears: the "malhão", gillnets with 100 to 3,000 m length and 4.0 to 6.0 m height, with 8 to 20 cm mesh, and kept vertically from the water column; the "gozeira", that is a bottom-set gillnet, has 500 to 1,000 m length and 2 to 3 m height, it has 5 to 8 cm mesh opening, and is used at the bottom in the open

sea; and the "tapagem", are nylon nets with 20 to 100 m length, approximately 2 m height, and 2 to 4 cm mesh opening, being used across the stream and against the ebb and flow (Almeida and Nahum 2015).

Gillnets with the smallest mesh (e.g. the "tapagem") catches juveniles, while the "gnats" capture about 97% of adult *C. acoupa* individuals. Along with *C. acoupa*, it catches other species of fish, equivalent to 20% of total production. This bycatch consists of 19% of other Sciaenidae (e.g. *Cynoscion microlepdotus*), 11% rays (e.g. *Hypanus guttatus*), 5% sharks (e.g. *Carcharhinus porosus*), and 65% other bony fish (e.g. *Bagre bagre*) (Almeida and Nahum 2015).

In addition, *C. acoupa* catch occurs throughout the year in Brazil. In the northern portion of this country, the average monthly catch per unit of effort (**CPUE**) is 35.67 kg/trip, especially in the first quarter, where there is the highest capture and CPUE of 50.61 kg/trip (Almeida and Nahum 2015). In the southeastern region of Brazil, the CPUE in 2013 was 60 kg/trip (Martins et al. 2019), thus showing a homogeneity in CPUE in Brazil. This CPUE results from the high value of the fish, which, according to Almeida et al. (2009), has a marketing price of about $ 12 per kg.

In other countries, where fishing is also targeting *C. acoupa*, there is poor information about fishing. However, in French Guiana, *C. acoupa* is considered the second most caught fish species. Fishing occurs throughout the year, but with greater catch in October and November. The main art of fishing is the drift gillnet, with meshes ranging from 140 to 200 mm stretched, which capture more than 75% of *C. acoupa* production. The average sales price for 2012 was approximately $ 3.3 per kg for dealers and almost $ 5.9 per kg for regional markets (Levrel 2012).

In Venezuela, the principal location of *C. acoupa* landing is Maracaibo, where the fisheries operate also with gillnets, with monofilament nylon ranging from 2 to 5 cm in stretched mesh sizes. The average length of the fish range between 40 and 45 cm of TL, with an average annual catch of 4,000 tons (Morales and Montaño 2011).

Therefore, the northern region of South America is responsible for more than 95% of *C. acoupa* annual production. In addition, fishing occurs throughout the year, especially the first quarter in Brazil, and fourth quarter in French Guiana and Venezuela. In addition, a high diversity of fishing gear is used to capture this species. The gillnets are the most common, and mesh smaller than 8 cm are most harmful to juveniles.

Fishing exploitation rate

Information on mortality and fishing exploitation is therefore of fundamental importance for understanding the impacts of fisheries on fish populations. These data are also scarce for *C. acoupa*, but the data indicate that the species is overexploited in virtually all capture sites.

In Northern Brazil, Souza et al. (2003) estimated an exploitation rate (E) of 0.72 per year for *C. acoupa*, showing an overexploitation. These findings corroborate with Oliveira (2018), who also indicated overexploitation ($E = 0.61\ year^{-1}$), but only for more coastal regions and juveniles. In the furthest region, where the largest specimens (adults) were found, there is an under-exploitation ($E = 0.19\ year^{-1}$).

Montaño and Morales (2013) estimated total mortality rate of 1.23 $year^{-1}$ and fishery mortality of 0.70 $year^{-1}$ to the Venezuela population, resulting in an exploitation rate of 0.57 $year^{-1}$. These exploitation rates, in Brazil and in Venezuela, are the result of fisheries of young individuals, as reported by Oliveira (2018), which in the northern portion of Brazil captures 54% of juveniles, and by Montaño and Morales (2013), that described sharp catches of young specimens in Venezuela, where they represent more than 90% of individuals caught.

The capture of juveniles of *C. acoupa* combined with overexploitation of these individuals, results in a decrease of the reproductive stock, causing fewer recruits to be generated, and the population tends to decrease due to mortality caused by overfishing. Therefore, this group of young individuals should receive priority attention, so that strategies are created to reduce their capture.

Fishermen's perceptions

Fishermen who have been capturing *C. acoupa* for a long time report a decline in the catch of this species in northern Brazil, stating that in addition to abundance, the catch size is also decreasing. This perception was reported in 2007 by Mourão et al. (2009) and reaffirmed in 2015 by Souza Junior et al. (2020), in which of the 240 respondents, 74% replied that catch had decreased. Nonetheless, even though it has already been reported, nothing has been done to mitigate this decrease. Notably, government leaders have not paid attention to these issues or made decisions on how to prevent this resource from becoming even scarcer.

In addition, fishermen believe that the reduction in population is mainly due to lack of management, resulting in invasion of the industrial fishing fleet in areas most commonly operated by artisanal fishing. Fishing grounds close to the coast, which use nets with smaller meshes, also report practices considered harmful to the environment, such as the use of very small nets, fixed traps (such as "fuzarcas"), "timbó", which causes a large mortality of juvenile fish (Mourão et al. 2009).

Still, in the fishermen's perception, the competent bodies should take initiatives to better manage the species, such as mesh size restrictions and adhere to the closed season, avoiding the capture of young individuals and ensuring the reproduction of *C. acoupa* (Mourão et al. 2009; Souza Junior et al. 2020). It is worth mentioning that for *C. acoupa* there are no specific planning measures to limit or control fishing effort; there are no records of any form of management in this fishery.

Fish technology

In addition to *C. acoupa* being a highly appreciated species, mainly in the northern region of South America, due to the meat quality (Isaac et al. 1998), it also presents other values with its by-product, for example the swimming bladder (popularly known as sticking) which has high economic value ranging from 7.50 to 8.40 USD/kg (Mourão et al. 2009). This by-product is used for the glue, gelatin, and clarifiers' production in

the wine industry and also as food in Asian countries (Cervigón 1993). Other works were also developed for the integrated used of *C. acoupa*, such as tanning the species skin that can be used to obtain leather, generating income and reducing environmental impacts (Eiras et al. 2015). In addition, the manufacture of by-products such as breaded residue and protein enrichment (Moura et al. 2015) aiming at the integrated use of fish, economic profitability and generating less waste in the environment.

Final considerations

Studies show that *C. acoupa* has k-strategist (slower growth, late maturation, and low annual fertility) species characteristics compared to other bony fish types, and has a high degree of vulnerability to fishing. In addition, there is heightened fishing for this species, causing a decrease in *C. acoupa* fishing stocks. These works also report a more intensive fishing for juveniles, further aggravating the population structure of this species. This high value placed on catching juveniles is related to fishing methods and the lack of fishery management. So far there are no restrictions on catching *C. acoupa*, leaving it vulnerable.

Although *C. acoupa* is highly exploited and vulnerable to fishing, the IUCN ranks it as the category of Least Concern (Chao et al. 2010), whereas in Brazil it is classified as the Near Threatened (ICMBio 2014). The conservation status of this species may be due to the lack of basic population dynamics information and fishing statistics, which are fundamental for the conservation and sustainable management of the species. Therefore, further updates on the conservation status of the species are required, as the latest version of IUCN was published in 2010.

The paucity of studies on this species makes it difficult to establish management measures and conservation status of *C. acoupa*. Therefore, further studies should be prioritized, especially on reproductive biology, age and growth and fishing exploitation. These aspects are fundamental for the understanding of the species, and the evaluation of fish stocks, as well as for the establishment of more adequate conservation management measures.

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Supplementary material 1

Table S1

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Data type: xlsx-file

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